(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 April 2003 (03.04.2003)

PCT

(10) International Publication Number
WO 03/028381 A2

(51) International Patent Classification[7]: H04N 7/26

(21) International Application Number: PCT/US02/29091

(22) International Filing Date:
13 September 2002 (13.09.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/962,286 24 September 2001 (24.09.2001) US

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 03/028381 A2

(54) Title: METHOD FOR DELIVERING TRANSPORT STREAM DATA

(57) Abstract: According to one embodiment, a system is disclosed. The system includes a transmission device that converts a transport stream in to a transport stream file (TSF), a transmission medium coupled to the transmission device and a set top appliance, coupled to the transmission medium that receives the TSF.

METHOD FOR DELIVERING TRANSPORT STREAM DATA

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FIELD OF THE INVENTION

[0002] The present invention relates to set top appliances; more particularly, the present invention relates to delivering MPEG-2 transport streams.

BACKGROUND

[0003] Along with the increasing interest in the Internet and the World Wide Web, appliances or set-top boxes similar to cable television boxes have been developed in an attempt to allow access to satellite transmissions and the Internet through the traditional television set. However, such attempts suffer from delays in accessing content. For instance, restricted bandwidth may cause transmission errors during the transmission of pure audio and video bit streams to a set top appliance. These transmission errors are received at the set top appliance as a

component of the bit stream data. As a result, the errors appear as signal degradation during the playback of the data at the set top appliance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The present invention will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the invention. The drawings, however, should not be taken to limit the invention to the specific embodiments, but are for explanation and understanding only.

[0005] Figure 1 illustrates one embodiment of a data delivery system;

[0006] Figure 2 is a block diagram of one embodiment of a computer system;

[0007] Figure 3 illustrates an exemplary transmission device and set top appliance;

[0008] Figure 4 is a block diagram of one embodiment of a transmission device and a set top appliance;

[0009] Figure 5 is a flow diagram for one embodiment of the operation of a transmission device; and

[0010] Figure 6 is a flow diagram for one embodiment of the operation of a set top appliance.

DETAILED DESCRIPTION

[0011] A method for delivering transport stream data to a set top appliance is described. According to one embodiment, audio and video bit streams are encoded at a transmission device and combined to form a single transport stream. The transport stream is converted into a file format and stored. Subsequently, the file is encoded for transport, modulated and transmitted to a set top appliance for access by a set top appliance user.

[0012] In the following description, numerous details are set forth. It will be apparent, however, to one skilled in the art, that the present invention may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form, rather than in detail, in order to avoid obscuring the present invention.

[0013] Reference in the specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment.

[0014] Some portions of the detailed descriptions that follow are presented in terms of algorithms and symbolic representations of operations on data bits within a computer memory. These algorithmic descriptions and representations are the means used by those skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. An algorithm is

here, and generally, conceived to be a self-consistent sequence of steps leading to a desired result. The steps are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated. It has proven convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like.

[0015] It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the following discussion, it is appreciated that throughout the description, discussions utilizing terms such as "processing" or "computing" or "calculating" or "determining" or "displaying" or the like, refer to the action and processes of a computer system, or similar electronic computing device, that manipulates and transforms data represented as physical (electronic) quantities within the computer system's registers and memories into other data similarly represented as physical quantities within the computer system memories or registers or other such information storage, transmission or display devices.

[0016] The present invention also relates to apparatus for performing the operations herein. This apparatus may be specially constructed for the required purposes, or it may comprise a general-purpose computer selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a computer readable storage medium, such as, but is

not limited to, any type of disk including floppy disks, optical disks, CD-ROMs, and magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs), EPROMs, EEPROMs, magnetic or optical cards, or any type of media suitable for storing electronic instructions, and each coupled to a computer system bus.

[0017] The algorithms and displays presented herein are not inherently related to any particular computer or other apparatus. Various general-purpose systems may be used with programs in accordance with the teachings herein, or it may prove convenient to construct more specialized apparatus to perform the required method steps. The required structure for a variety of these systems will appear from the description below. In addition, the present invention is not described with reference to any particular programming language. It will be appreciated that a variety of programming languages may be used to implement the teachings of the invention as described herein.

[0018] The instructions of the programming language(s) may be executed by one or more processing devices (e.g., processors, controllers, control processing units (CPUs), execution cores, etc.).

[0019] Figure 1 illustrates one embodiment of a data delivery system 100. System 100 includes a transmission device 110 and a set top appliance 120 coupled via a transmission medium 130. In one embodiment, transmission device 110 operates as a source device that sends data objects to set top appliance 120, operating as a receiving device. The objects may be, for example, a transport stream, a data file, an executable, or other digital objects. The objects are sent via

data transmission medium 130. The data transmission medium 130 may be one of many mediums.

[0020] According to one embodiment, transmission medium 130 is a satellite transmission. However, in other embodiments, transmission medium 130 may be a terrestrial broadcast, an internal network connection, an Internet connection, or other connections. According to one embodiment, set-top appliance 120 is implemented for digital satellite services in order to receive content from transmission device 110. However, in other embodiments, set top appliance 120 may be a personal computer (PC) coupled to transmission device 110, wherein the transmission medium is the Internet.

[0021] Figure 2 is a block diagram of one embodiment of a computer system 200. Computer system 200 may be implemented as transmission device 110 or set top appliance 120 (both shown in Figure 1). The computer system 200 includes a processor 201 that processes data signals. Processor 201 may be a complex instruction set computer (CISC) microprocessor, a reduced instruction set computing (RISC) microprocessor, a very long instruction word (VLIW) microprocessor, a processor implementing a combination of instruction sets, or other processor device.

[0022] In one embodiment, processor 201 is a processor in the Pentium® family of processors including the Pentium® II family and mobile Pentium® and Pentium® II processors available from Intel Corporation of Santa Clara, California. Alternatively, other processors may be used. Figure 2 shows an example of a computer system 200 employing a single processor computer.

However, one of ordinary skill in the art will appreciate that computer system 200 may be implemented using multiple processors.

[0023] Processor 201 is coupled to a processor bus 210. Processor bus 210 transmits data signals between processor 201 and other components in computer system 200. Computer system 200 also includes a memory 213. In one embodiment, memory 213 is a dynamic random access memory (DRAM) device. However, in other embodiments, memory 213 may be a static random access memory (SRAM) device, or other memory device. Memory 213 may store instructions and code represented by data signals that may be executed by processor 201.

[0024] According to one embodiment, a cache memory 202 resides within processor 201 and stores data signals that are also stored in memory 213. Cache 202 speeds up memory accesses by processor 201 by taking advantage of its locality of access. In another embodiment, cache 202 resides external to processor 201.

[0025] Computer system 200 further includes a bridge memory controller 211 coupled to processor bus 210 and memory 213. Bridge/memory controller 211 directs data signals between processor 201, memory 213, and other components in computer system 200 and bridges the data signals between processor bus 210, memory 213, and a first input/output (I/O) bus 220. In one embodiment, I/O bus 220 may be a single bus or a combination of multiple buses.

[0026] In a further embodiment, I/O bus 220 is a Peripheral Component Interconnect adhering to a Specification Revision 2.1 bus developed by the PCI

Special Interest Group of Portland, Oregon. In another embodiment, I/O bus 220 may be a Personal Computer Memory Card International Association (PCMCIA) bus developed by the PCMCIA of San Jose, California. Alternatively, other busses may be used to implement I/O bus. I/O bus 220 provides communication links between components in computer system 200.

[0026] A network controller 221 is coupled I/O bus 220. Network controller 221 links computer system 200 to a network of computers (not shown in Figure 2) and supports communication among the machines. A display device controller 222 is also coupled to I/O bus 220. Display device controller 222 allows coupling of a display device to computer system 200, and acts as an interface between the display device and computer system 200. In one embodiment, display device controller 222 is a monochrome display adapter (MDA) card. In other embodiments, display device controller 222 may be a color graphics adapter (CGA) card, an enhanced graphics adapter (EGA) card, an extended graphics array (XGA) card or other display device controller.

[0026] The display device may be a television set, a computer monitor, a flat panel display or other display device. The display device receives data signals from processor 201 through display device controller 222 and displays the information and data signals to the user of computer system 200. A video camera 223 is also coupled to I/O bus 220.

[0027] Computer system 200 includes a second I/O bus 230 coupled to I/O bus 220 via a bus bridge 224. Bus bridge 224 operates to buffer and bridge data signals between I/O bus 220 and I/O bus 230. I/O bus 230 may be a single bus or

a combination of multiple buses. In one embodiment, I/O bus 230 is an Industry Standard Architecture (ISA) Specification Revision 1.0a bus developed by International Business Machines of Armonk, New York. However, other bus standards may also be used, for example Extended Industry Standard Architecture (EISA) Specification Revision 3.12 developed by Compaq Computer, et al.

[0028] I/O bus 230 provides communication links between components in computer system 200. A data storage device 231 is coupled to I/O bus 230. I/O device 231 may be a hard disk drive, a floppy disk drive, a CD-ROM device, a flash memory device or other mass storage device. A keyboard interface 232 is also coupled to I/O bus 230. Keyboard interface 232 may be a keyboard controller or other keyboard interface. In addition, keyboard interface 232 may be a dedicated device or can reside in another device such as a bus controller or other controller. Keyboard interface 232 allows coupling of a keyboard to computer system 200 and transmits data signals from the keyboard to computer system 200. An audio controller is also coupled to I/O bus 230. Audio controller 233 operates to coordinate the recording and playing of sounds.

[0029] As described above, transmission device 110 transmits streaming data to set top appliance 120. According to one embodiment, Moving Picture Experts Group 2 (MPEG-2) transport streams are transmitted from transmission device 110 to set top appliance 120. The transport streams are used to combine programs made up of packetized elementary streams (PES) coded data with one or more independent time bases into a single stream. Typically, in the MGEG-2

standard, an individual program does not have to have a unique time base, but if it does, the time base is the same for all of the elements of the individual program.

[0030] Figure 3 illustrates an exemplary system implemented to deliver streaming data to a set top appliance. Typically, pure audio and video bit streams are received at the transmission device where they are separately encoded using MPEG-2 encoding techniques. Subsequently, the audio and video bit streams are combined at a multiplexer to form a single bit stream. After, the single bit stream is formed, it is modulated and transmitted from the transmission device to the set top appliance.

[0031] The set top appliance receives the bit stream data and de-modulates the data. Subsequently the data is filtered. After filtering, the data can be played at an attached display and/or audio device as it is received. Alternatively, the data may be stored at the appliance for later playback. The procedure for transporting the compressed bit stream from the transmission device to the set-top appliance, and for thereafter decompressing the bit stream at the set-top appliance, so that one of the many picture sequences is decompressed and may be displayed in real-time is specified in the Industry Standard Organization (ISO) 13818-1 Standard. ISO 13818-1 is the systems or transport layer portion of the MPEG-2 standard. One of ordinary skill in the art will appreciate that other MPEG standard streams (e.g., MPEG-1, Layer 3 (MP3), MPEG-4, etc.) may be implemented.

[0032] The problem with the conventional system described in Figure 3 is that regardless of whether the set-top appliance plays the received data back live,

or records the data to disk, there is a significant potential for errors. Since the bit stream data is transmitted live from the transmission device to the set top appliance, dedicated full-time bandwidth is required. If there is not sufficient bandwidth to handle the "live" bit stream data, packets may be dropped, resulting in signal degradation when the set top appliance plays the data. The signal degradation appears regardless of whether the data is immediately played upon receipt at the set top appliance or stored to disk for later playback since the signal errors are stored as well.

[0033] The term "live" is defined as streaming data that is transmitted from the transmission device to the set top appliance. For example, the data being streamed to the set top appliance may be from an occurring event, or from a pre-recorder event, delivered to the transmission device. Nevertheless, the data is considered live since the set top appliance is incapable of distinguishing the difference between data from a live event and pre-recorded data that has been received.

[0034] According to one embodiment, a transport stream file (TSF) is generated and stored at a transmission system and delivered to a set top appliance as a file. A TSF is a data file that contains the bit stream data that is received at a set top appliance via a reliable delivery mechanism without errors attributed to transmission. Moreover, dedicated bandwidth is not necessary for delivery of the TSF to a set top appliance. **Figure 4** is a block diagram of one embodiment of a transmission device 110 and a set top appliance 120.

[0035] Referring to **Figure 4**, transmission device 110 includes a video

encoder 411, an audio encoder 412 a multiplexer (MUX) 413, a transport file generator 414, a file transport encode module 415 and file disk 420. In addition, transmission device 110 includes a data insertion module 416, a MUX 417, a modulator 418 and a transmitter 419.

[0036] Video encoder 411 and audio encoder 412 form video and audio elementary streams of received data, respectively. Encoders 411 and 412 packetize the elementary streams into PES coded data. MUX 413 multiplexes the PES of audio data, video data, and other systems data into a system stream. Transport file generator 414 receives the combined stream of packetized data and converts the stream into a file format.

[0037] Encode module 415 provides encoding of the TSF for transport. In one embodiment, encode module 425 uses Forward Error Correction (FEC) and carousel ling to encode the data. FEC provides for the mitigation of errors arising during the transmission of data over transmission medium 310. With a data carousel, encode module 415 partitions the TSF into equal length packet symbols. Thus, the FEC codes are used in a data carousel fashion in order to provide reliability by cycling through and transmitting the encoding symbols instead of the source signals.

[0038] File disk 420 is implemented to store the TSF after it is generated. In one embodiment, file disk 420 is implemented using data storage 231 (**Figure 2**). Data insertion module 416 encapsulates the encoded packet stream IP data into Multi Protocol Encapsulation (MPE) packets implemented by MPEG-2. MUX 417 is an MPEG-2 multiplexer that combines multiple input transport streams into a

single output transport stream that is to be transmitted. Modulator 418 merges the packet data stream into a carrier for transmission. Transmitter 419 transmits the file data via transmission medium 130. As described above, transmission may be implemented as a satellite transmission. Thus, transmitter 419 transmits the signals to uplink for satellite.

[0039] Figure 5 is a flow diagram for one embodiment of the operation of transmission device 110. At processing block 510, audio and video bit streams are encoded at encoder 412 and encoder 411, respectively. At processing block 520, the audio and video bit streams are combined at multiplexer 413 to form a transport stream. At processing block 530, the transport stream is converted into a TSF format.

[0040] At processing block 540, the TSF file is stored at file disk 415. At processing block 550, the TSF is encoded for file transport at encoder 415. At processing block 560, the data is encapsulated at data insertion 416 into PES coded data. At processing block 570, the data is multiplexed at MUX 417 to form a transport stream. At processing block 580, the data is modulated at modulator 550. At processing block 590, the data is transmitted from device 110.

[0041] Referring back to Figure 4, set top 120 includes a receiver 421, demodulator 424, de-multiplexer (DE-MUX) 425, data extraction module 426 a decode module 427 an disk 428. Receiver 421 receives the TSF from transmission medium 130. De-modulator 424 extracts the packet data stream from the carrier. DE-MUX 425 separates the received transport stream into one or more output transport streams. Data extraction module 416 extracts the packet stream of data.

Decode module decodes the FEC coded packets. Disk 428 is implemented to store the TSF at set top appliance 120.

[0042] Figure 6 is a flow diagram for one embodiment of the operation of set top appliance 120. At processing block 610, the TSF data is received at set top appliance 120. At processing block 620, the data is de-modulated. At processing block 630, the data is de-multiplexed and decoded. At processing block 640, the TSF is stored to the set top appliance 120 hard disk.

[0043] The above-described method of delivering a transport stream in a one-way broadcast helps to ensure that content is delivered in an error free format. This type of delivery is significant in providing a customer with a great experience in watching/listening to content.

[0044] Whereas many alterations and modifications of the present invention will no doubt become apparent to a person of ordinary skill in the art after having read the foregoing description, it is to be understood that any particular embodiment shown and described by way of illustration is in no way intended to be considered limiting. Therefore, references to details of various embodiments are not intended to limit the scope of the claims which in themselves recite only those features regarded as the invention.

CLAIMS

What is claimed is:

1. A system comprising:

a transmission device that converts a transport stream in to a transport stream file (TSF);

a transmission medium coupled to the transmission device; and

a set top appliance, coupled to the transmission medium, that receives the TSF.

2. The system of claim 1 wherein the transmission device comprises:

a video encoder that encodes video bit streams received at the transmission device;

an audio encoder that encodes that encodes audio bit streams received at the transmission device;

a first multiplexer, coupled to the audio encoder and the video encoder, that combines the encoded audio and video bit streams to form a transport stream; and

a TSF generator, coupled to the first multiplexer, that converts the transport stream into the TSF.

3. The system of claim 2 wherein the transmission device further comprises:

an encode module that encodes the TSF for transport;

a data insertion module coupled to the encode module;

a second multiplexer coupled to the data insertion module;

a modulator coupled to the second multiplexer; and

a transmitter coupled to the modulator.

4. The system of claim 3 wherein the encode module uses forward error

correction (FEC) and carousel ling to encode the TSF:

5. The system of claim 3 wherein the set top appliance comprises:

a receiver;

a demodulator coupled to the receiver;

a de-multiplexer, coupled to the demodulator;

a data extraction module coupled to the de-multiplexer;

a decode module coupled to the data extraction module; and

data storage coupled to the decode module.

6. The system of claim 1 wherein the transmission medium is a satellite transmission.

7. The system of claim 1 wherein the transmission medium is a terrestrial broadcast.

8. The system of claim 1 wherein the transmission medium is the Internet.

9. A transmission device comprising:

a video encoder that encodes that encodes video bit streams received at the transmission device;

an audio encoder that encodes that encodes audio bit streams received at the transmission device;

a first multiplexer, coupled to the audio encoder and the video encoder, that combines the encoded audio and video bit streams to form a transport stream; and

a transport stream file (TSF) generator, coupled to the first multiplexer, that converts the transport stream into the TSF.

10. The transmission device of claim 9 further comprising:

an encode module that encodes the TSF;

a data insertion module coupled to the encode module;

a second multiplexer coupled to the data insertion module;

a modulator coupled to the second multiplexer; and

a transmitter coupled to the modulator.

11. A method comprising:

encoding audio and video bit streams at a transmission device;

combining the audio and video bit streams to form a transport stream; and

converting the transport stream to a transport stream file (TSF).

12. The method of claim 11 further comprising:

encoding the TSF for transport;

multiplexing the TSF;

modulating the TSF; and

transmitting the TSF.

13. The method of claim 12 further comprising:

receiving the TSF at a set top appliance;

demodulating the TSF;

decoding the TSF; and

storing the TSF.

14. A method comprising:

receiving a transport stream file (TSF) at a set top appliance via a transmission medium; and

storing the TSF at the set top appliance.

15. The method of claim 14 further comprising:

demodulating the TSF;

de-multiplexing the TSF; and

decoding the TSF;

16. An article of manufacture including one or more computer readable media that embody a program of instructions wherein the program of instructions, when executed by a processing unit, causes the processing unit to:

encode audio and video bit streams at a transmission device;

combine the audio and video bit streams to form a transport stream; and

convert the transport stream to a transport stream file (TSF).

17. The article of manufacture of claim 16 wherein the program of instructions, when executed by a processing unit, further causes the processing unit to

encode the TSF for transport;

multiplex the TSF;

modulate the TSF; and

transmit the TSF.

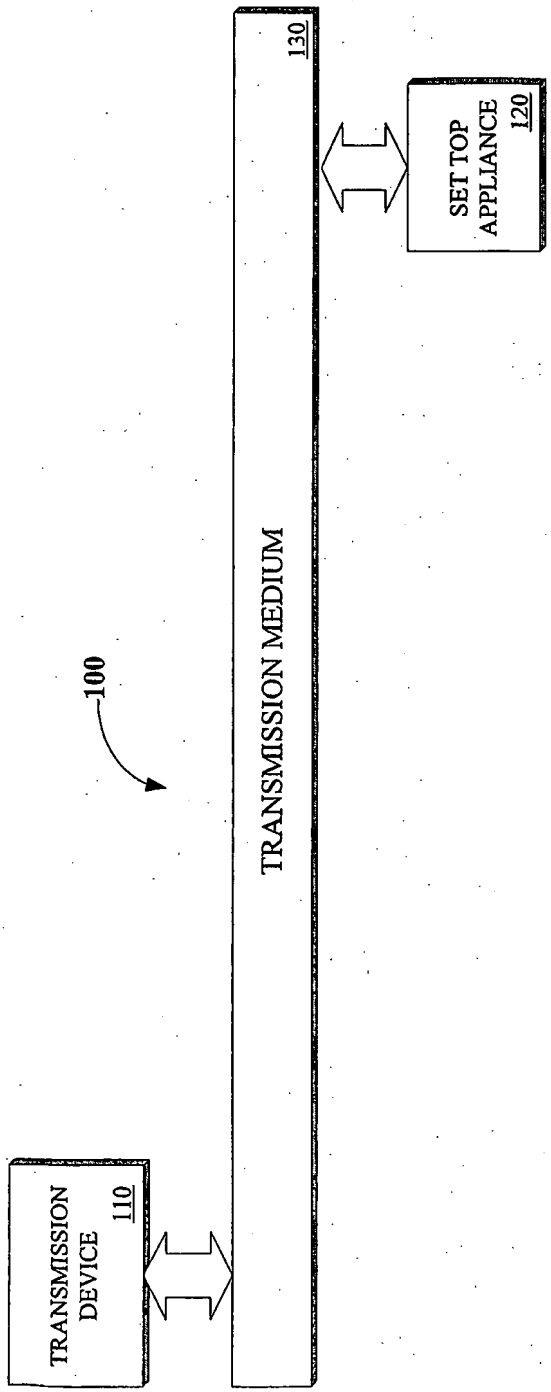
100
TRANSMISSION DEVICE
110
TRANSMISSION MEDIUM
130
SET TOP APPLIANCE
120

FIG. 1

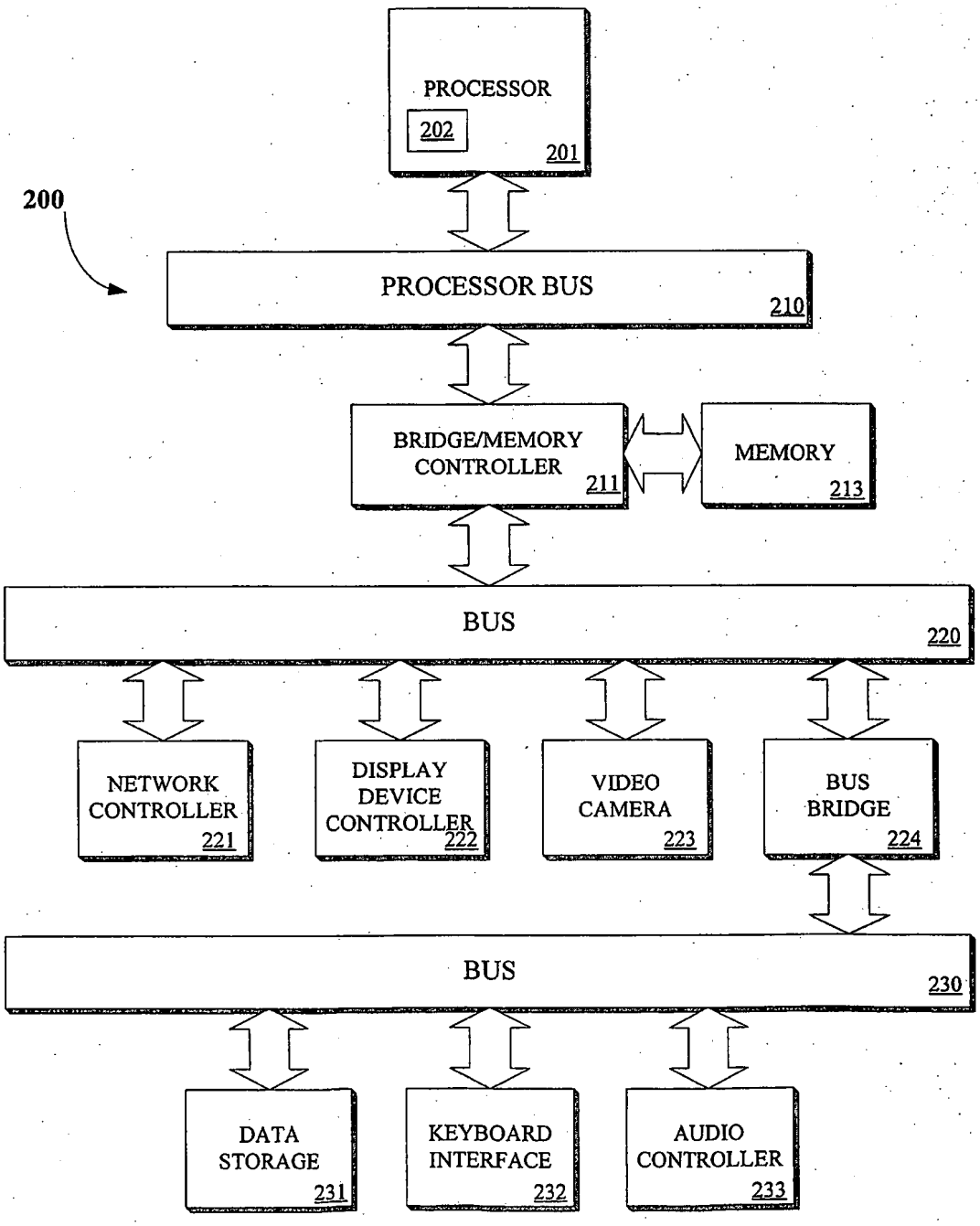
200
PROCESSOR
202
201
PROCESSOR BUS
210
BRIDGE/MEMORY CONTROLLER
211
MEMORY
213
BUS
220
NETWORK CONTROLLER
221
DISPLAY DEVICE CONTROLLER
222
VIDEO CAMERA
223
BUS BRIDGE
224
BUS
230
DATA STORAGE
231
KEYBOARD INTERFACE
232
AUDIO CONTROLLER
233

FIG. 2

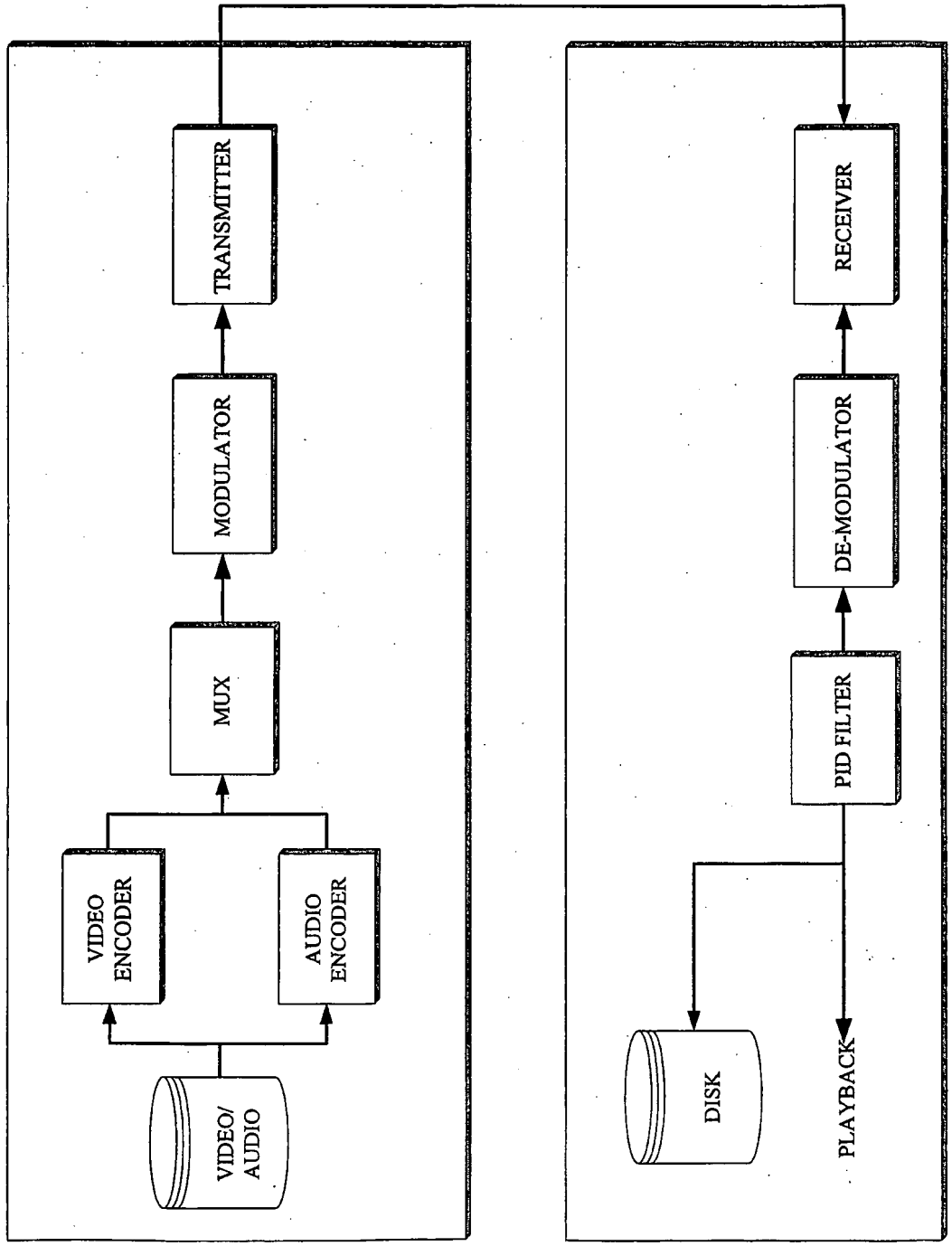

FIG. 3 (PRIOR ART)

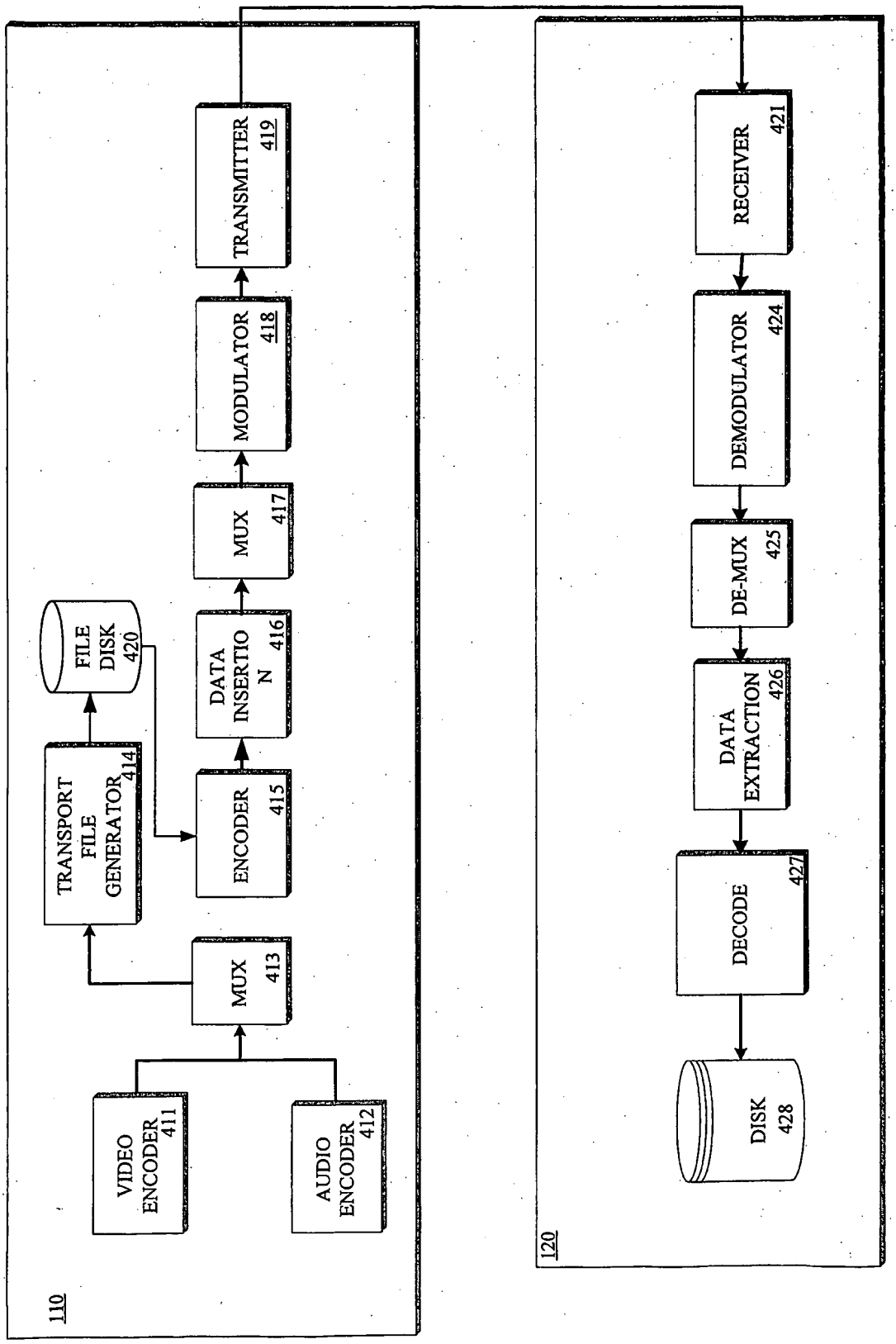
110
VIDEO ENCODER 411
AUDIO ENCODER 412
MUX 413
TRANSPORT FILE GENERATOR 414
ENCODER 415
DATA INSERTION 416
MUX 417
MODULATOR 418
TRANSMITTER 419
FILE DISK 420
120
RECEIVER 421
DEMODULATOR 424
DE-MUX 425
DATA EXTRACTION 426
DECODE 427
DISK 428

FIG. 4

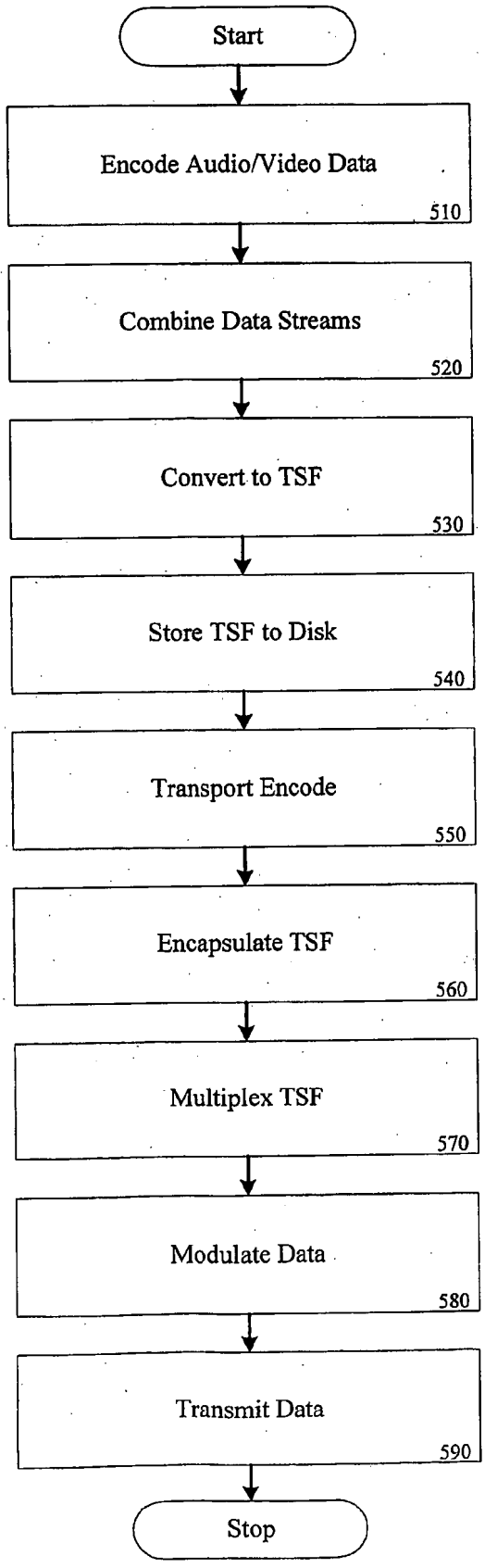
Start
Encode Audio/Video Data
510
Combine Data Streams
520
Convert to TSF
530
Store TSF to Disk
540
Transport Encode
550
Encapsulate TSF
560
Multiplex TSF
570
Modulate Data
580
Transmit Data
590
Stop

FIG. 5

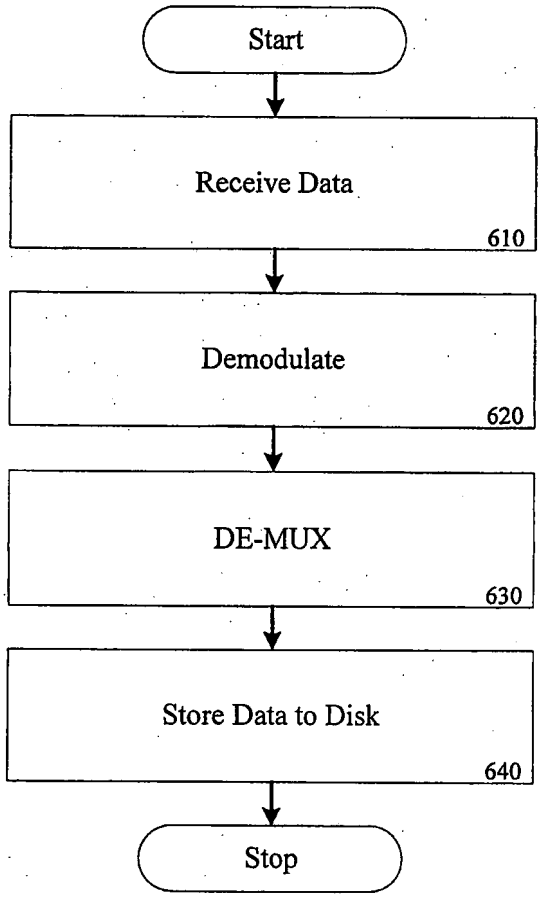
Start
Receive Data
610
Demodulate
620
DE-MUX
630
Store Data to Disk
640
Stop

FIG.
6